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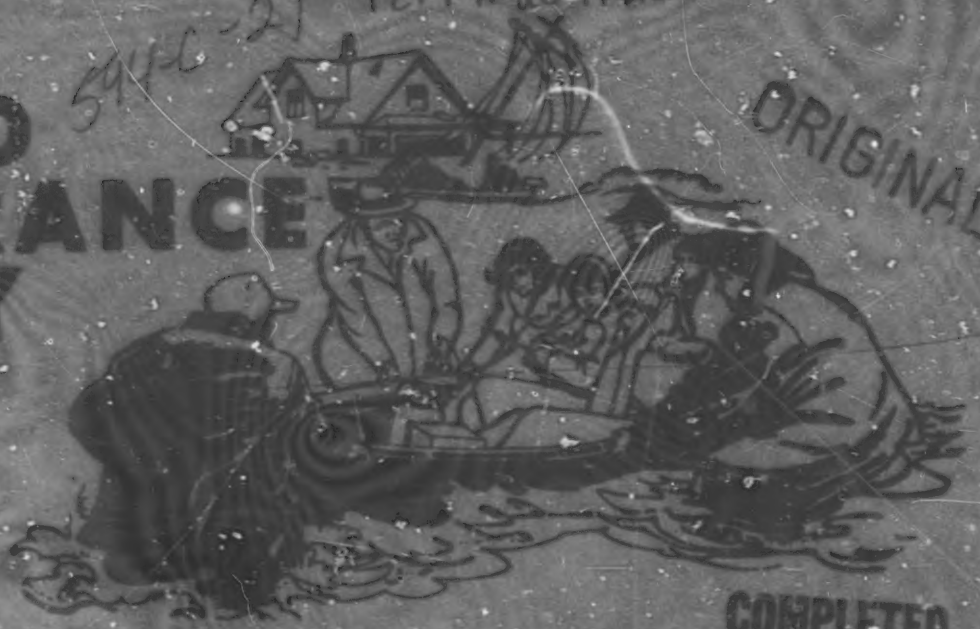
FLOOD INSURANCE STUDY



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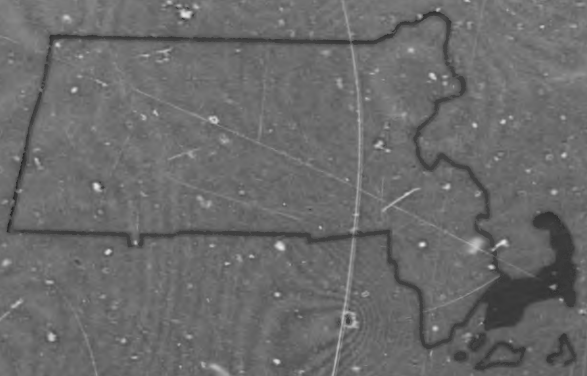
TOWN OF ORLEANS, MASSACHUSETTS BARNSTABLE COUNTY



SEPTEMBER 4, 1985

Federal Emergency Management Agency

COMMUNITY NUMBER - 250010

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FLOOD INSURANCE STUDY
TOWN OF ORLEANS, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Orleans, Barnstable County, Massachusetts, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by PRC Harris for the Federal Emergency Management Agency (FEMA), under Contract No. H-4776 (completed in June 1981) and under Contract Modification No. M010. This study was completed in August 1983.

1.3 Coordination

On March 24, 1978, an initial Consultation and Coordination Officer's (CCO) meeting, attended by representatives of FEMA, PRC Harris (the study contractor), and the Town of Orleans, was held to identify the scope of study and to explain the technical aspects of the study.

The Massachusetts Department of Commerce and Development, the U. S. Department of Housing and Urban Development, U. S. Geological Survey (USGS), and Avis Airmap, Inc., were contacted for various types of pertinent information. High-water marks from serious historical flood events in Orleans were obtained from the USGS and the New England Division of the U. S. Army Corps of Engineers (COE). The COE also

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furnished tide gage records for Boston Harbor and the Cape Cod Canal at Sandwich; the National Ocean Survey (NOS) furnished tide tables for Boston.

An intermediate CCO meeting was held on November 8, 1983, to review the study progress. On October 18, 1984, the results of the study were reviewed at a final CCO meeting held with representatives of FEMA, the town, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Orleans, Barnstable County, Massachusetts. The area of study is shown on the Vicinity Map (Figure 1).

Tidal flooding including its wave action from the Atlantic Ocean (the Nauset Beach shore), Cape Cod Bay (the Namskaket shore), Rock Harbor Creek, Town Cove, Pleasant Bay, Little Pleasant Bay and its east branch, The River, and the Namequoit River were studied by detailed methods. Several areas of shallow flooding within the town were also determined as a result of the detailed analysis. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through August 1988.

Uncle Seth's Pond, Deep Pond, Shoal Pond, Twinings Pond, Sarahr Pond, Quanset Pond, Uncle Israels Pond, ponds between Quanset and Namequoit Roads, Wash Pond, Cliff Pond, Gould Pond, Baker Pond, Crystal Lake, cranberry bog north of Pine Road, Uncle Harvey Pond, Cedar Pond, Icehouse Pond, and cranberry bogs between U. S. Highway 6A and Cape Cod Bay were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Town of Orleans.

2.2 Community Description

The Town of Orleans is located in southeastern Massachusetts at the elbow of Cape Cod. It is approximately 96 miles from Boston; approximately 93 miles from Providence, Rhode Island; and approximately 22 miles from Hyannis. Orleans is bordered by the Town of Eastham to the north, the Town of Brewster and Cape Cod Bay to the west, the Town of Chatham to the south, and the Atlantic Ocean to the east. The 1970 population of the Town of Orleans was 3,055 with a population density of 219 persons per square mile. This figure represents a 30 percent increase in population over the 1960 figure.

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FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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Developed flood plain areas in Orleans include the area near Rock Harbor Creek, areas along Town Cove, and areas along the coastline.

The tidal shoreline of the Town of Orleans is 56.1 miles long. The eastern shoreline, included in the Cape Cod National Seashore, is 4.8 miles in length and is exposed to the Atlantic Ocean. Pleasant Bay and Little Pleasant Bay, also in the eastern sector, are somewhat protected from the open ocean by the peninsula forming Nauset Beach. Little Pleasant Bay, which borders Pleasant Bay, receives flow from The River and the Namequoit River, which are both tidal estuaries. Town Cove and Mill Pond are tidal and flow east to the Atlantic Ocean via Nauset Harbor. The 1.3 mile Namskaket shore faces Cape Cod Bay. Little Namskaket Creek, Namskaket Creek, and Rock Harbor Creek are tidal estuaries that flow into Cape Cod Bay.

The climate of Orleans is moderate, with temperatures ranging from a monthly average of 31.7 degrees Fahrenheit (°F) in January to 71.1°F in July (Reference 1). Normal annual precipitation is 40.28 inches.

The terrain of Orleans is hilly with elevations rarely rising to over 50 feet, except in the western sector where elevations are as high as 140 feet. Town Cove in the north is an elongated cove entering from the Atlantic Ocean on the east. Pleasant Bay and Little Pleasant Bay form an indentation into the southeastern sector of Orleans. They are separated on the east from the Atlantic Ocean by Nauset Beach, a long fingerlike peninsula extending southward. Most of the soil in Orleans is droughty, sandy loam.

2.3 Principal Flood Problems

Orleans, because of its coastal New England location, is highly susceptible to northeasters. Northeasters often last long enough to be accompanied by at least one high tide, resulting in severe coastal flooding.

In addition to flooding, damaging waves may accompany the tidal surge in coastal areas. The shorelines of both Namskaket and Nauset Beach are subject to wave action.

2.4 Flood Protection Measures

Part of Orleans is within the Cape Cod National Seashore where development is prohibited and natural conditions are conserved. Orleans also has Conservancy Districts established by protective bylaws which regulate future development within flood plain areas. This not only protects against flood damages to new structures, but also assures that the natural flood storage areas in the town will be protected.

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3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Analyses were carried out to establish the peak elevation-frequency relationships for each flooding source studied in detail affecting the community.

In New England, flooding of low lying coastal areas is caused primarily by storm surge generated by extratropical coastal storms called northeasters. Elevation-frequency relationships for the southeastern coast of Massachusetts were determined through a log-Pearson Type III analysis on the tide gages at Boston Harbor (86 years of record) and at the Cape Cod Canal entrance in Sandwich (21 years of record) (References 2 and 3). These analyses show that the northeaster storm of February 1978 was approximately a 100-year event.

The northeaster is typically a large counterclockwise wind circulation around a low pressure area. The storm radius is often as much as 1,000 miles, and the storm speed is approximately 25 miles per hour (mph). Sustained wind speeds of 10 to 40 mph are common, with shorter term wind speeds of up to 70 mph. Such information is available on synoptic weather charts published by the National Weather Service (Reference 4).

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For the Atlantic coast, information on storm surge elevations was obtained from the tidal flood profiles for the 10-, 50-, and 100-year floods that were developed in 1980 by the COE (Reference 5). These elevations represent the best data available for the eastern coast of Orleans. A more detailed analysis, such as one by computer modeling, was not merited, as this area is part of the Cape Cod National Seashore and is not subject to development.

To calculate storm surge and total storm tide elevations produced by historic storms for Cape Cod Bay a two-dimensional model was used to numerically simulate coastal storm surges (Reference 6). The initial portion of the model is a simulation of meteorological conditions associated with storms.

Seventeen historic storms were modeled, with the input consisting of a central pressure index, peripheral pressure, maximum storm radius, and storm track. The model output consisted of pressure and wind fields for the storm and arrays of the resulting wind stress and barometric rise of the water surface.

The wind stress and barometric rise arrays were saved for input to the second portion of the model, which consists of a simulation of the physical characteristics of the study area. For the western coast of Orleans, the entire Cape Cod shoreline was modeled. Input consisted of the arrays specified by the northeaster model and a two-dimensional grid system to define the study area, where depths are specified for every grid point, and land areas are defined. The model utilized an explicit, finite difference numerical scheme to solve the basic momentum equations in two dimensions. The output is a time series of storm surge elevations for every grid point.

The model was calibrated with the February 1978 storm. Model surge elevations, added to the predicted tides, were compared to recorded elevations (Reference 7). Sixteen other storms were run, and the model results were compared to recorded elevations at the Boston and Cape Cod Canal tide gages. For each storm, ratios were developed to compare the elevation at each coastal point to the elevation at Boston. A single ratio for each point was developed based on all storm models to relate tidal flooding at the point to tidal flooding at Boston, and these ratios were applied to the Boston gage records to derive an elevation-frequency curve for the western coast of Orleans. Historic high-water mark elevations for these major floods are shown in Table 1. Elevations for selected locations during the February 1978 storm are shown in Table 2.

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TABLE 1 - HIGH-WATER MARK ELEVATIONS

Storm Date	Elevation (feet) Boston Gage	Cape Cod Gage
February 1978	10.3	10.1
March 1976	8.6	*
February 1972	9.1	8.2
November 1968	7.8	7.3
February 1968	6.1	6.1
December 1967	7.7	8.4
April 1967	7.5	7.3
January 1966	7.9	7.9
March 1962	8.5	8.0
March 1961	7.4	6.8
January 1961	8.9	8.8
March 1960	8.2	7.5
December 1959	9.5	9.0
April 1958	8.7	8.2
March 1957	6.9	6.6
March 1956	8.8	9.0
November 1944	9.1	*

*No record available

TABLE 2 - ELEVATIONS FOR FEBRUARY 1978 STORM

Location	Elevation (feet)
Brewster, Cape Cod Bay	
Keel mark on concrete post at the end of Breakwater Road	13.11*
Dennis, Cape Cod Bay	
Top of side door stoop at 37 Dr. Bottero Road	13.18*
Provincetown, Provincetown Harbor	
Observation of surveyor's rod on face of concrete seawall at northeast corner of municipal parking lot near MacMillan Wharf	10.00

*Due to wave action

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A one-dimensional computer model was used to route the outer coast surge hydrographs through tidal portions of estuarine streams to determine the storm surge elevations in the protected areas of Rock Harbor Creek, Town Cove, Pleasant Bay, Little Pleasant Bay and its east branch, The River, and Namequoit River (Reference 8). Input to the model consisted of stream depth, stream width, freshwater flows, and information on stream branching for a series of grids. The model solves the momentum equation in one dimension, and generates output consisting of a time series of elevations for each grid. The model was calibrated to the February 1978 storm, and hydrographs for the 10-, 50-, 100-, and 500-year storms were routed up the river to develop the elevation-frequency relationship for each stream reach.

The stillwater elevations for the 10-, 50-, 100-, and 500-year floods have been determined for areas studied by detailed methods and are summarized in Table 3.

TABLE 3 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
ATLANTIC OCEAN				
Entire shoreline within community	6.5	8.4	10.0	14.5
CAPE COD BAY				
Entire shoreline within community	10.3	11.3	11.6	12.7
ROCK HARBOR CREEK				
Confluence to Rock Harbor Road	10.3	11.3	11.6	12.7
Rock Harbor Road to approximately 1,300 feet downstream of Town Way	10.4	11.4	11.7	12.8
Approximately 1,300 feet downstream of Town Way to Tidal Limit	10.4	11.5	11.8	12.8
TOWN COVE				
Nauset Beach shoreline to Snow Point	6.6	8.5	10.1	14.6
Snow Point to Tidal Limit	6.7	8.6	10.1	14.6

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TABLE 3 - SUMMARY OF STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
PLEASANT BAY				
Entire shoreline within community	4.7	6.6	7.9	14.8
LITTLE PLEASANT BAY AND EAST BRANCH				
Pleasant Bay to Namequoit Point	4.8	6.7	8.0	15.0
Namequoit Point to Pochet Island	4.8	6.8	8.1	15.1
Pochet Island to Tidal Limit	5.0	7.0	8.3	15.2
THE RIVER				
Little Pleasant Bay to Frostfish Cove	4.8	6.8	8.1	15.1
Frostfish Cove to Tidal Limit	5.0	7.0	8.3	15.3
NAMEQUOIT RIVER				
The River to approximately 4,300 feet upstream of The River	4.8	6.8	8.2	15.1
Approximately 4,300 feet upstream of The River to Tidal Limit	4.9	7.0	8.4	15.5

The analyses reported in this study reflect the stillwater elevations due to tidal and wind setup effects. The effects of wave action were also considered in the determination of flood hazard areas. Coastal structures that are located above stillwater flood elevations can still be severely damaged by wave runup, wave-induced erosion, and wave-borne debris. For example, during the northeasters of January and February 1978, considerable damage along the Massachusetts coast was caused by wave activity, even though most of the damaged structures were above the high-water level. The extent of wave runup past stillwater levels depends greatly on the wave conditions and local topography.

Wave heights and corresponding wave crest elevations were determined using the National Academy of Sciences (NAS) methodology (Reference 9). The wave runup was determined using the methodology developed by Stone and Webster Engineering Corporation for FEMA (Reference 10).

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3.2 Hydraulic Analyses

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The COE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (References 11 and 12). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding. A wave runup analysis was performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing wave heights and corresponding wave crest elevations was developed by the NAS (Reference 9). The NAS methodology is based on three major concepts.

First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

where H_b is the crest to trough height of the maximum or breaking wave and d is the stillwater depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Z_w = S_* + 0.7H_* = S_* + 0.55d$$

where Z_w is the wave crest elevation, S_* is the stillwater elevation at the site, and H_* is the wave height at the site. The 0.7 coefficient is the portion of the wave height which reaches above the stillwater elevation. H_b is the upper limit for H_*.

The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or man-made obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$H_t = BH_i$$

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where H_t is the transmitted wave height, H_i is the incident wave height, and B is a transmission coefficient ranging from 0.0 to 1.0. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by the NAS to determine B for vegetation, buildings, natural barriers such as dunes, and man-made barriers such as breakwaters and seawalls (Reference 9).

The third concept deals with unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

The methodology for analyzing wave runup was developed by Stone and Webster Engineering Corporation (Reference 10). The wave runup computer program operates using an ensemble of deepwater wave heights, H_i, the stillwater elevation, S*, a wave period, T_s, and beach slope, m. For Orleans, wave heights range from 3 feet up to the significant wave height of 30 feet; the wave period equals 12.5 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 100-year storm surge. Accurate topographic, land-use, and land cover data are required for the coastal analyses. Maps of the study area, at a scale of 1:4,800 with a contour interval of 5 feet were used for the topographic data (Reference 13). Depths below mean low water were determined from NOS nautical charts (Reference 14). The land-use and land cover data were obtained by field surveys and aerial photographs (Reference 15).

Wave heights and wave runup were computed along transects which were located perpendicular to the average mean shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Figure 2, "Transect Location Map," illustrates the location of the transects for the community.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using the topographic maps, land-use and land cover data, and engineering judgment to determine the areal extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes. Selected beach transects with stillwater elevations for the 10- and 100-year recurrence intervals and wave envelope profiles for the 100-year recurrence interval are shown on the Coastal Profiles (Exhibit 1).

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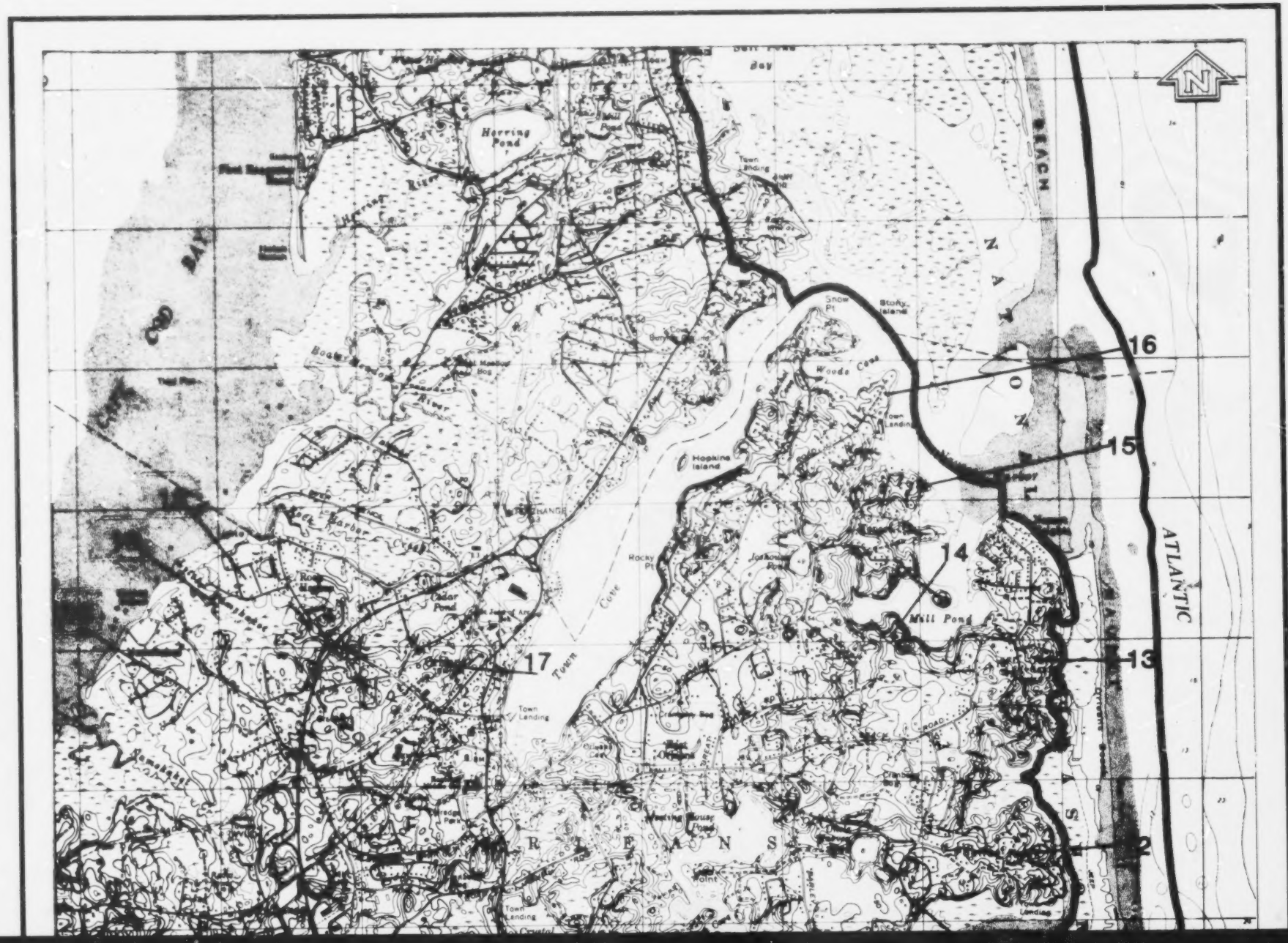
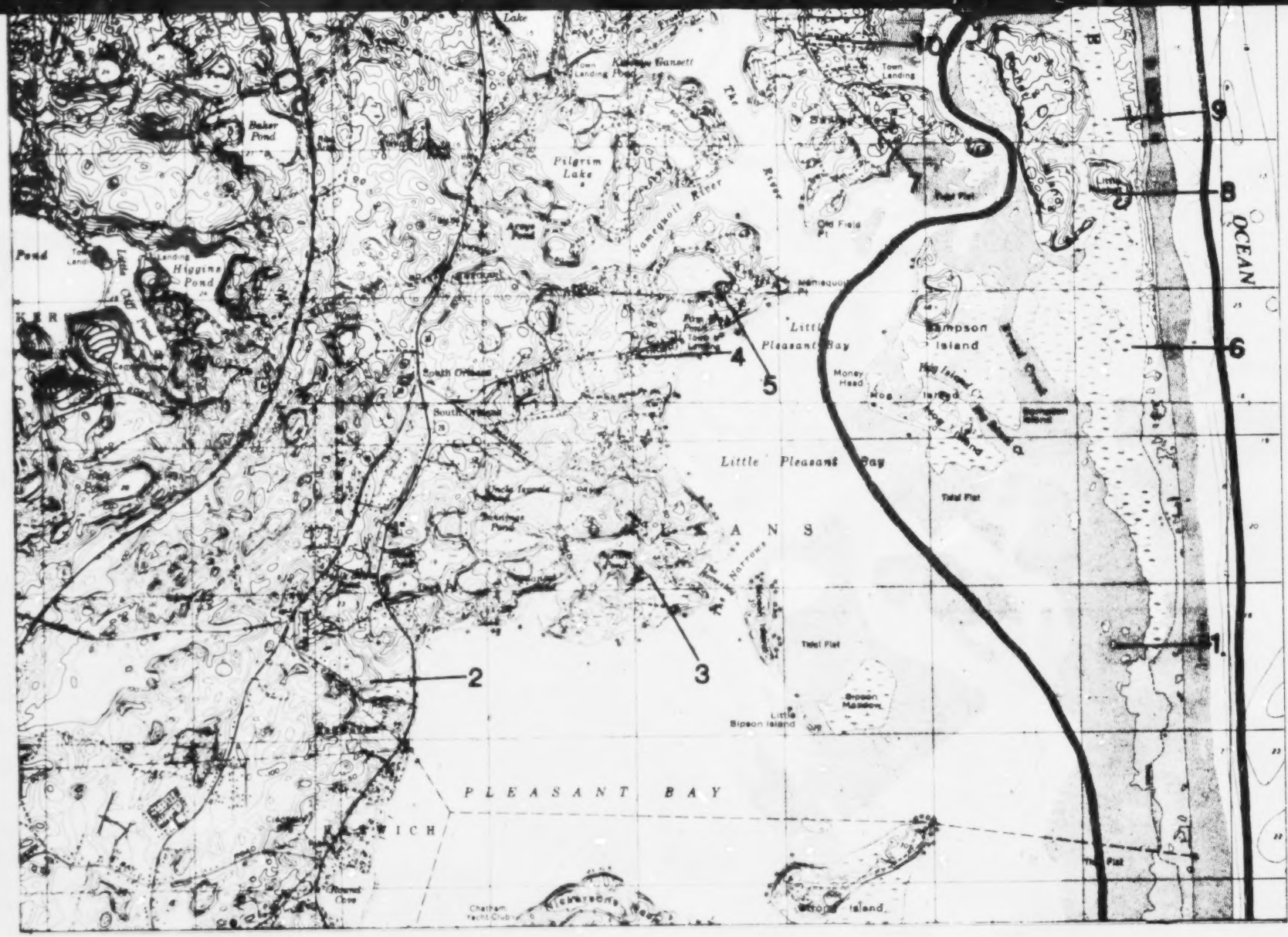

N
Herring Pond
Hopkins Island
Mill Pond
Cedar Pond
ATLANTIC
BEACH
16
15
14
13
12
17
R E A N S



FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

APPROXIMATE SCALE
3000 0 3000 6000 9000 FEET

TRANSECT LOCATION MAP

FIGURE 2

12A

Areas of shallow flooding are shown along portions of the shoreline. These areas are the result of overtopping of the dune crest line along the Atlantic Ocean shore. They are located along the back slope of the frontal dune line, at the following approximate positions: from 1,200 feet to 1,600 feet north of the north end of the parking lot; from 700 feet north to 1,100 feet south of the parking lot; from 1,600 feet south of the parking lot to the jeep trail crossing east of Little Pochet Island; intermittently from 2,500 feet to 6,600 feet south of the above crossing; and from 7,600 feet south of the above crossing southward to the corporate limits. These areas range between 100 and 300 feet in width.

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For tidal areas without wave action, the 100-year and 500-year boundaries were delineated using topographic maps (Reference 13). For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 100-year flood plain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

The coastline shown on the maps should not be associated with a particular elevation. This line is the shoreline at the time of the aerial photography from which the maps were prepared. The coastline shown on the maps is not mean sea level; therefore, there is no relationship between the zero elevation shown on the transect profiles and this coastline.

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The approximate studied areas were delineated using the Flood Hazard Boundary Map for the Town of Orleans (Reference 16). For the areas studied by approximate methods, only the 100-year flood plain boundary is shown. The shallow flooding areas were delineated using topographic maps (Reference 13).

The 100- and 500-year flood plain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for the flooding sources studied in detail in the Town of Orleans.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard. In areas where wave height and wave runup analyses were performed, reaches were determined for areas of the coastline, represented by a transect or group of transects, which have the same physical characteristics. For each transect the coastal high hazard zone (V zone) may be divided into two reaches to reflect those areas where wave runup is a dominant factor and those areas where wave runup does not dominate and elevations are determined by the wave height analysis. The reaches determined for the Town of Orleans are summarized in Table 4.

TABLE 4 - FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean	6.5	10.0	035	V7	13-25
			055	V11	12-15
			055	A11	11-12
			035	A7	8-17
	Shallow Flooding - Average Depth 2 Feet			A0	--

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

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TABLE 4 - FLOOD INSURANCE ZONE DATA - continued

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Cape Cod Bay	10.3	11.6	015	V3	15
			020	V4	14-17
			025	A5	12-14
			020	A4	12-14
			015	A3	12
Rock Harbor Creek	10.3	11.6	020	A4	12
			015	A3	12
	10.4	11.7	015	A3	12
	10.4	11.8	015	A3	12
Town Cove	6.6	10.1	055	V11	13-16
			055	A11	11-12
			050	A10	10-12
			045	A9	10-12
			040	A8	10
	6.7	10.1	055	V11	12-15
			050	A10	10-12
			040	A8	10
Pleasant Bay	4.7	7.9	050	V10	10-12
			050	A10	8-10
			045	A9	8-10
			035	A7	8-10
			030	A6	8
Little Pleasant Bay and its east branch	4.8	8.0	050	V10	10
			050	A10	8-10
			045	A9	8-10
			040	A8	8-10
			030	A6	8
	4.8	8.1	050	A10	8-10
			040	A9	8-10
			035	A7	8
	5.0	8.3	045	A9	8-10
			035	A7	8

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

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TABLE 4 - FLOOD INSURANCE ZONE DATA - continued

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
The River	4.8	8.1	045	A9	8-10
			035	A7	8
	5.0	8.3	035	A7	8
Namequoit River	4.8	8.2	035	A7	8
	4.9	8.4	035	A7	8

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.

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Zone AO:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown but no FHFs are determined.
Zones A3, A4, A5, A6, A7, A8, A9, A10, and A11:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zones V3, V4, V7, V10, and V11:	Special Flood Hazard Areas along coasts inundated by the 100-year flood that have additional velocity hazards associated with waves of 3-foot amplitude or greater; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 4.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of Orleans is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

The Flood Insurance Studies for the Towns of Eastham and Brewster are currently being prepared (References 17 and 18). The results of those studies

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will be in exact agreement with the results of this study for Orleans. The Flood Insurance Study for the Town of Chatham is also being prepared (Reference 19). The stillwater elevations used for the Chatham study are different from those used for this study due to differences in near shore topography; therefore, differences in BFEs exist between the two studies.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

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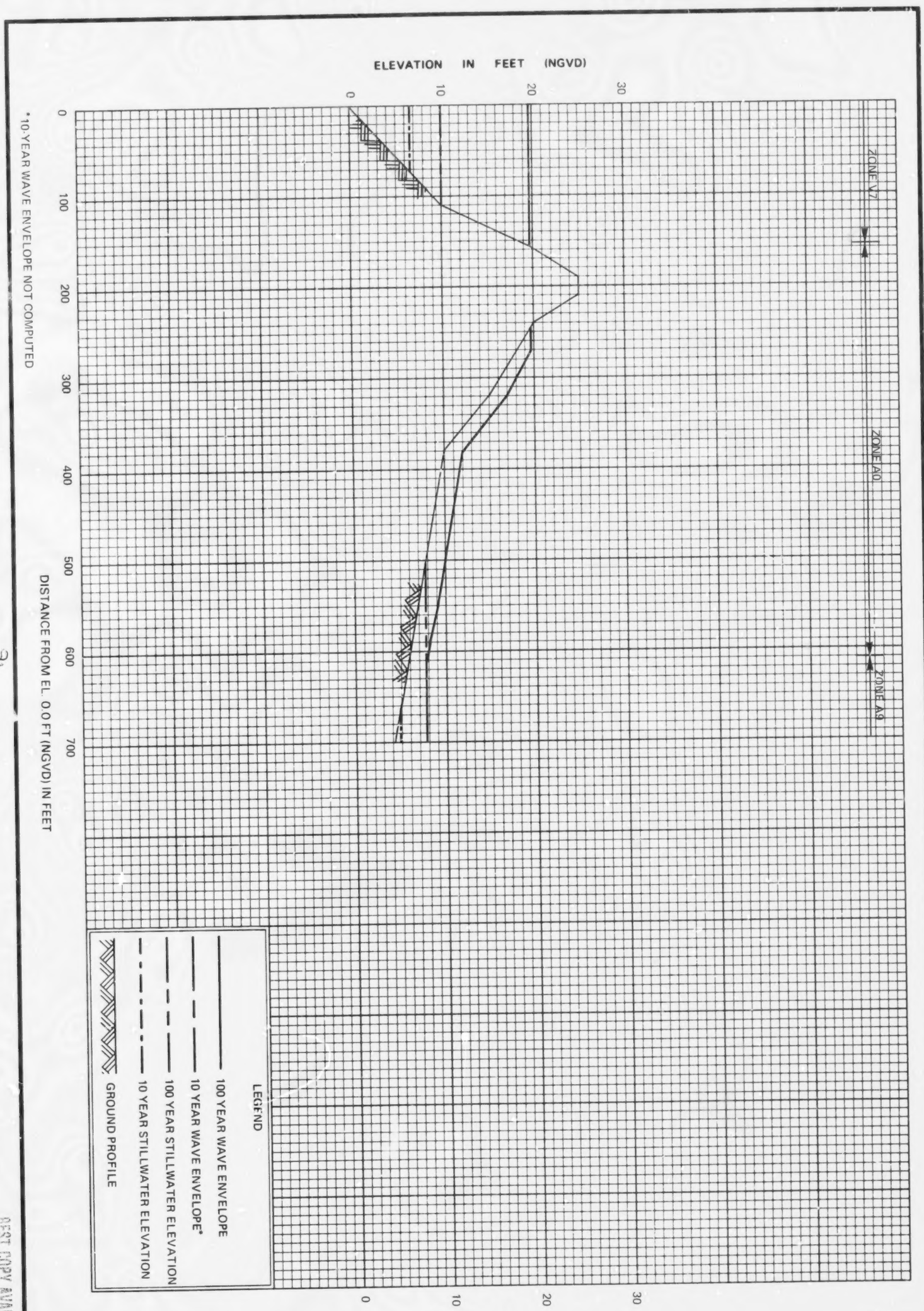

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

COASTAL PROFILES

TRANSECT 1

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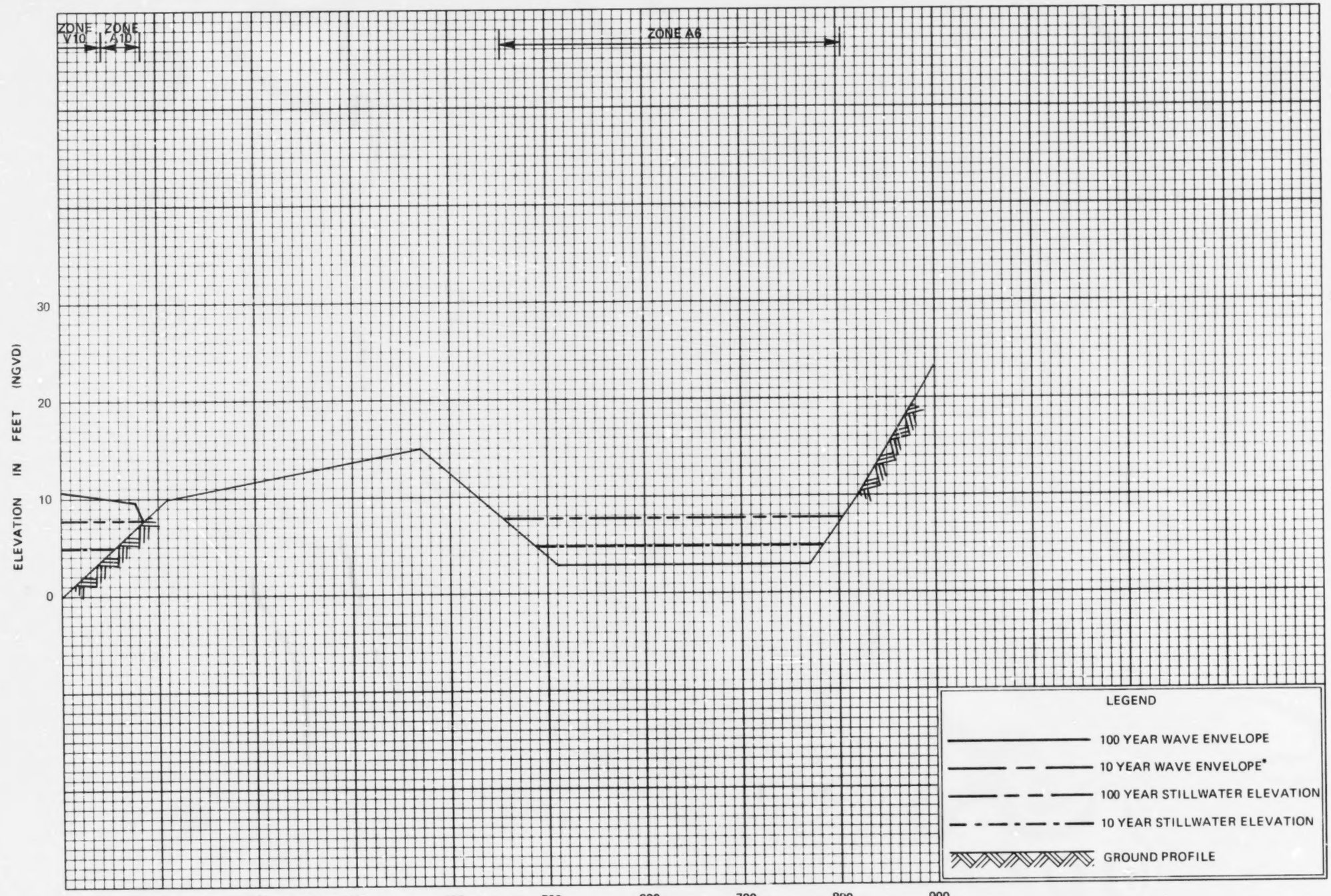

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COASTAL PROFILES

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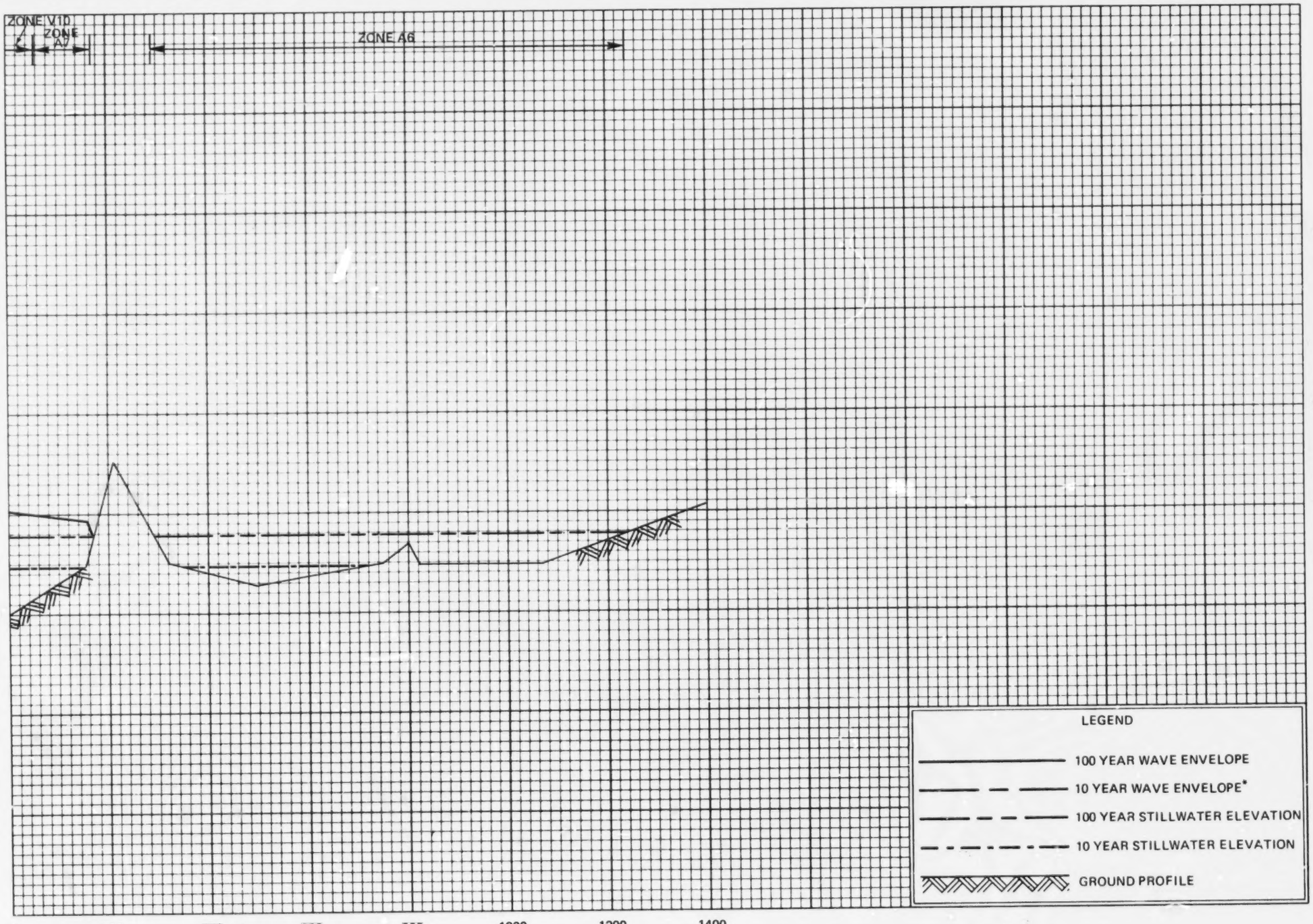

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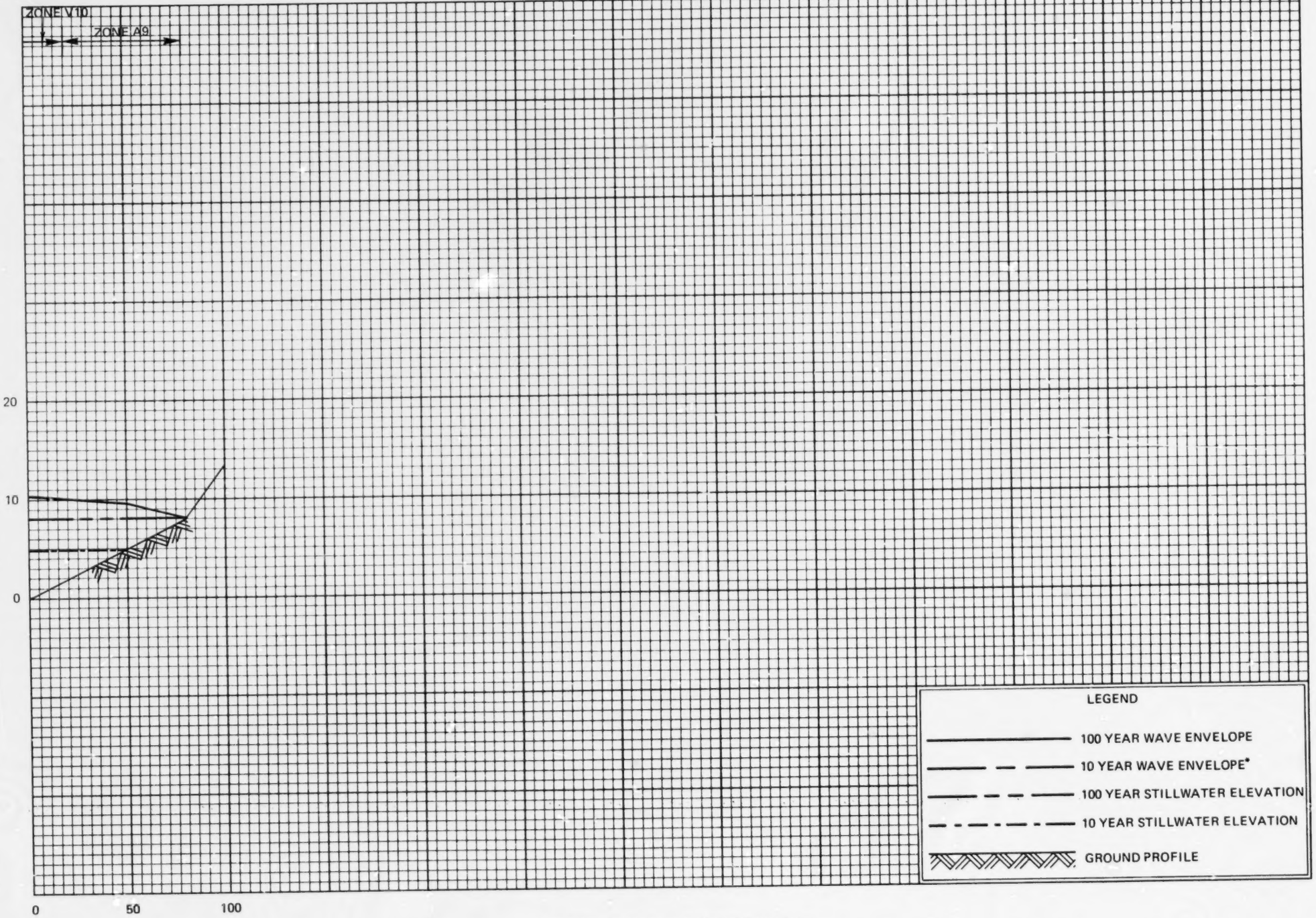

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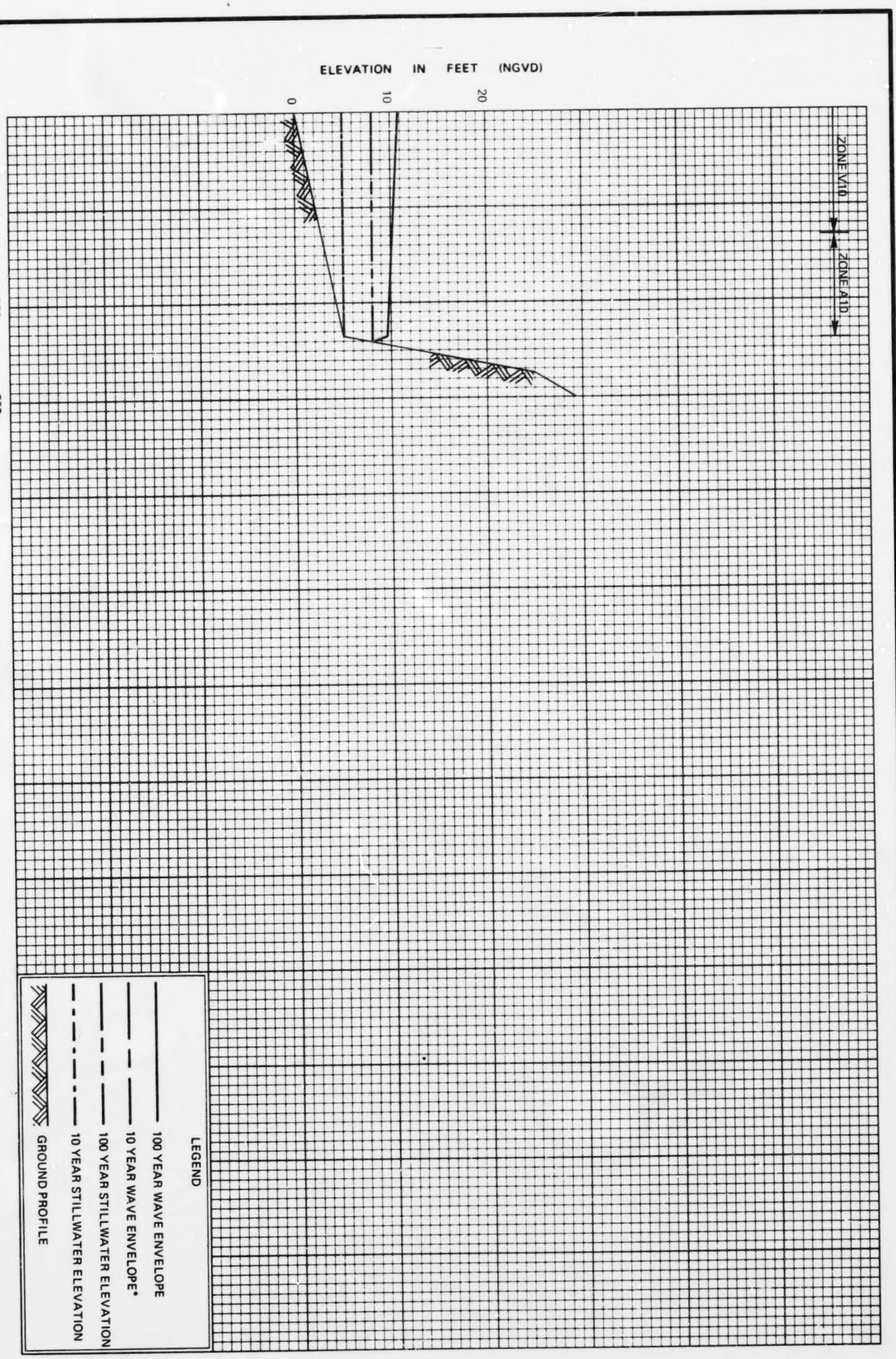

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TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

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COASTAL PROFILES

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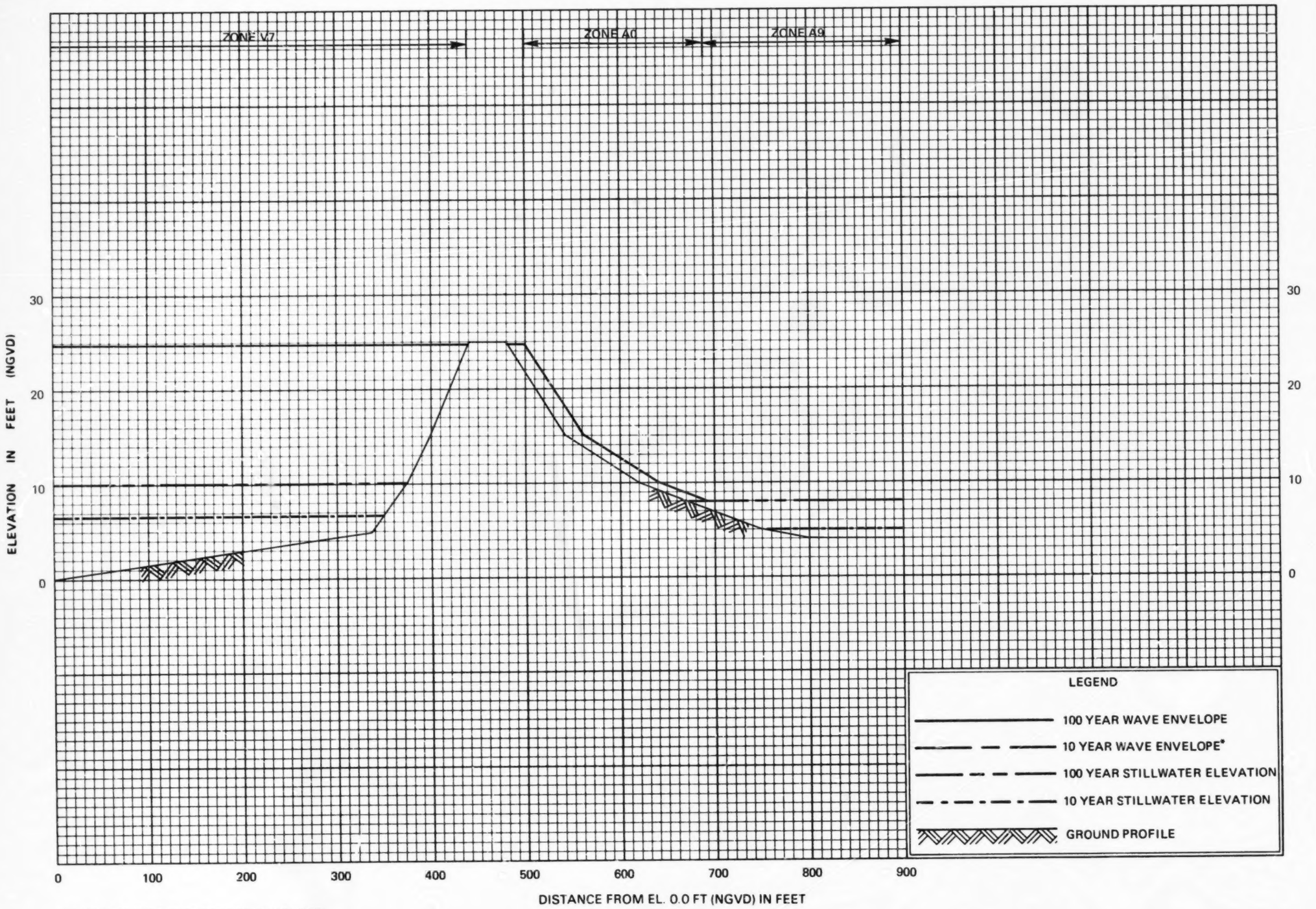

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(BARNSTABLE CO.)

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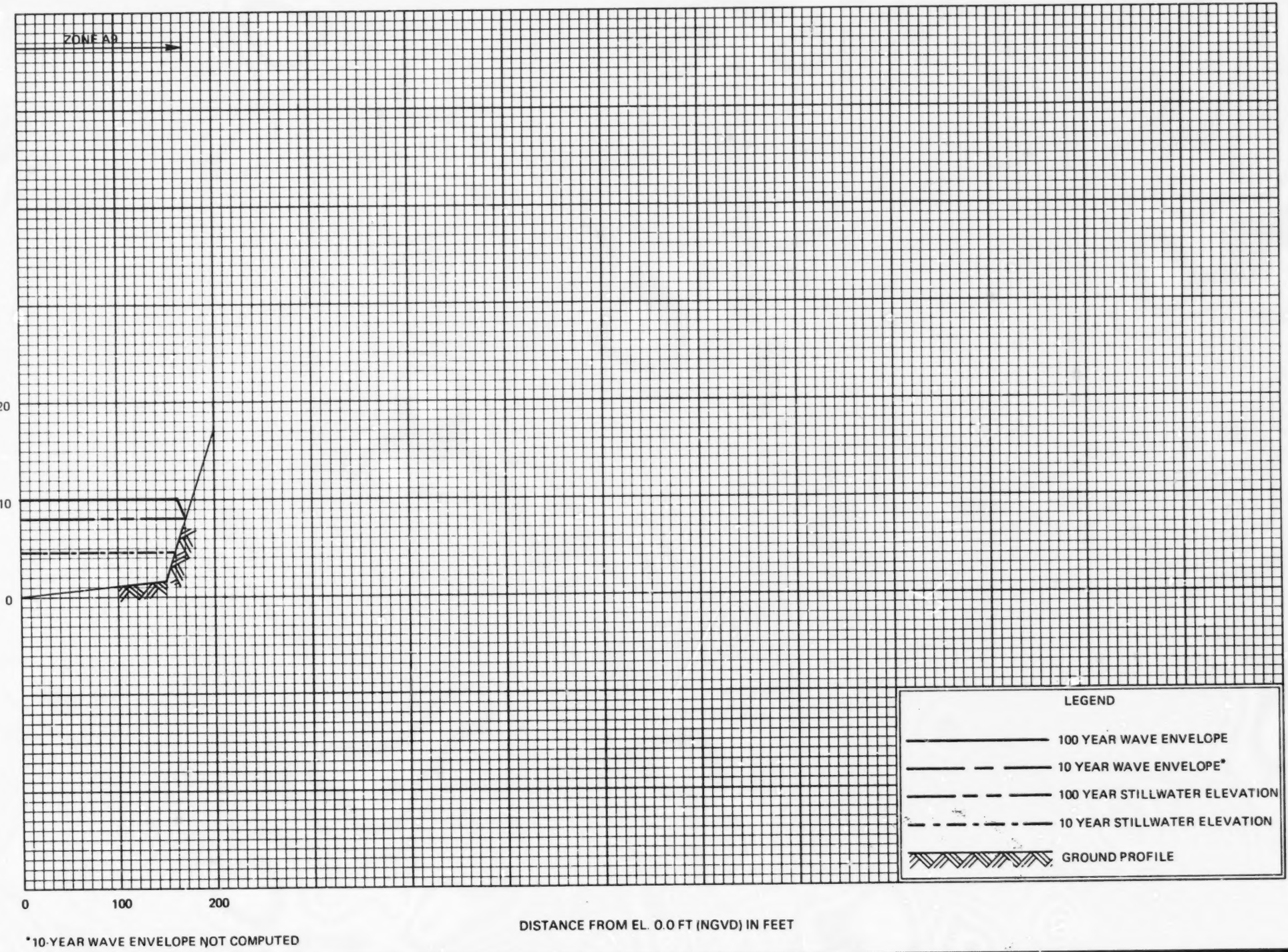

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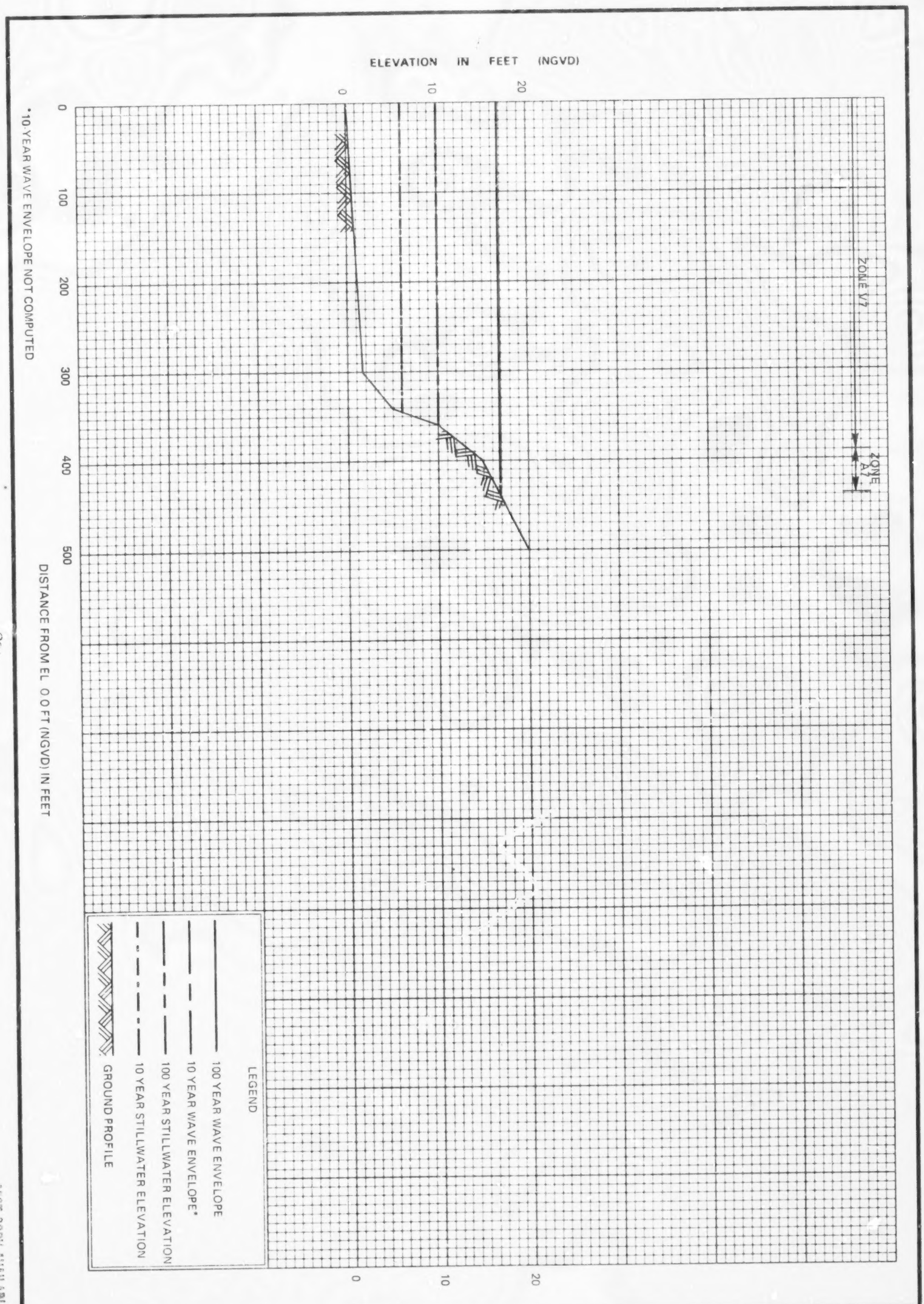

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TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

COASTAL PROFILES

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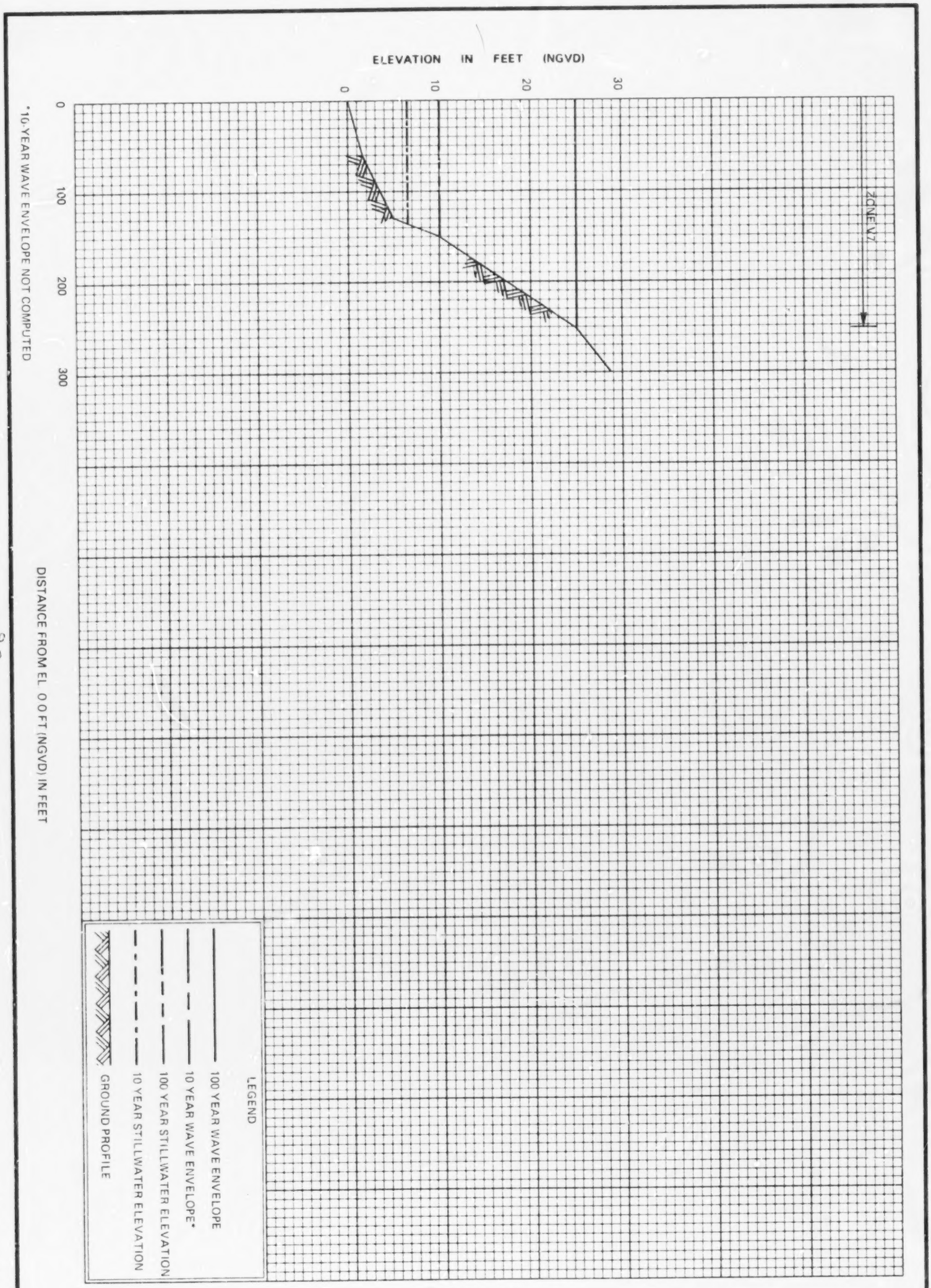

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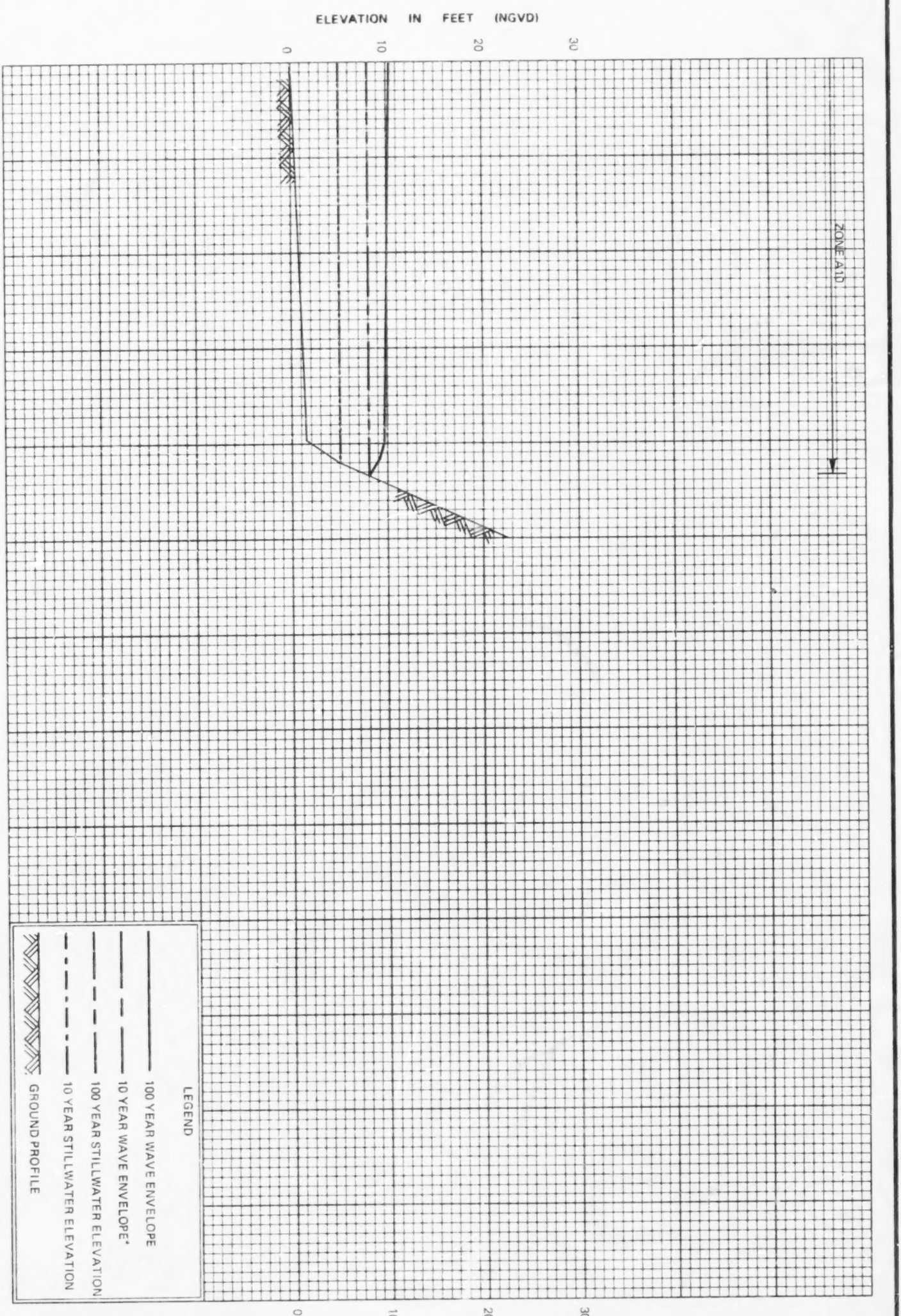

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

COASTAL PROFILES

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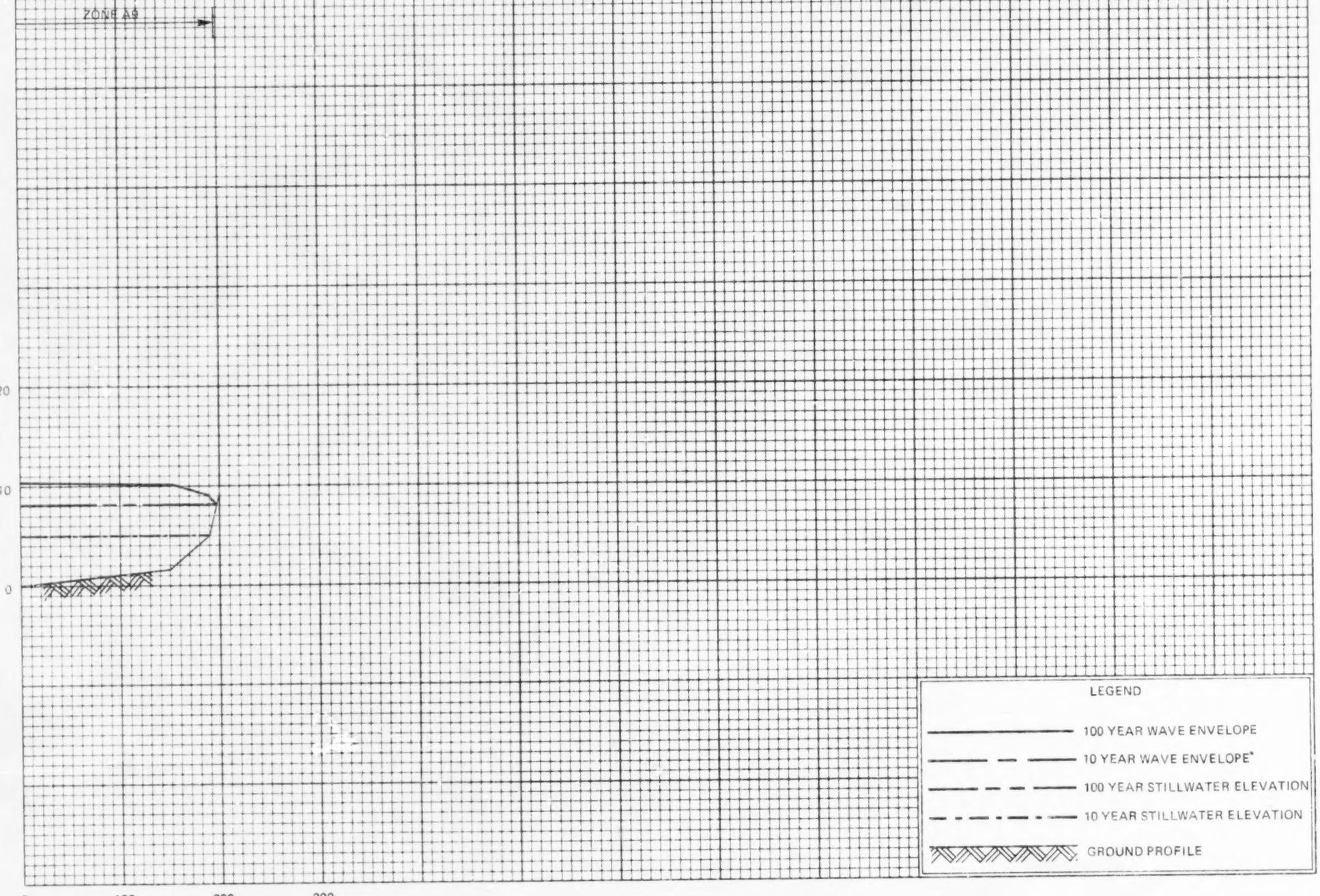

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TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

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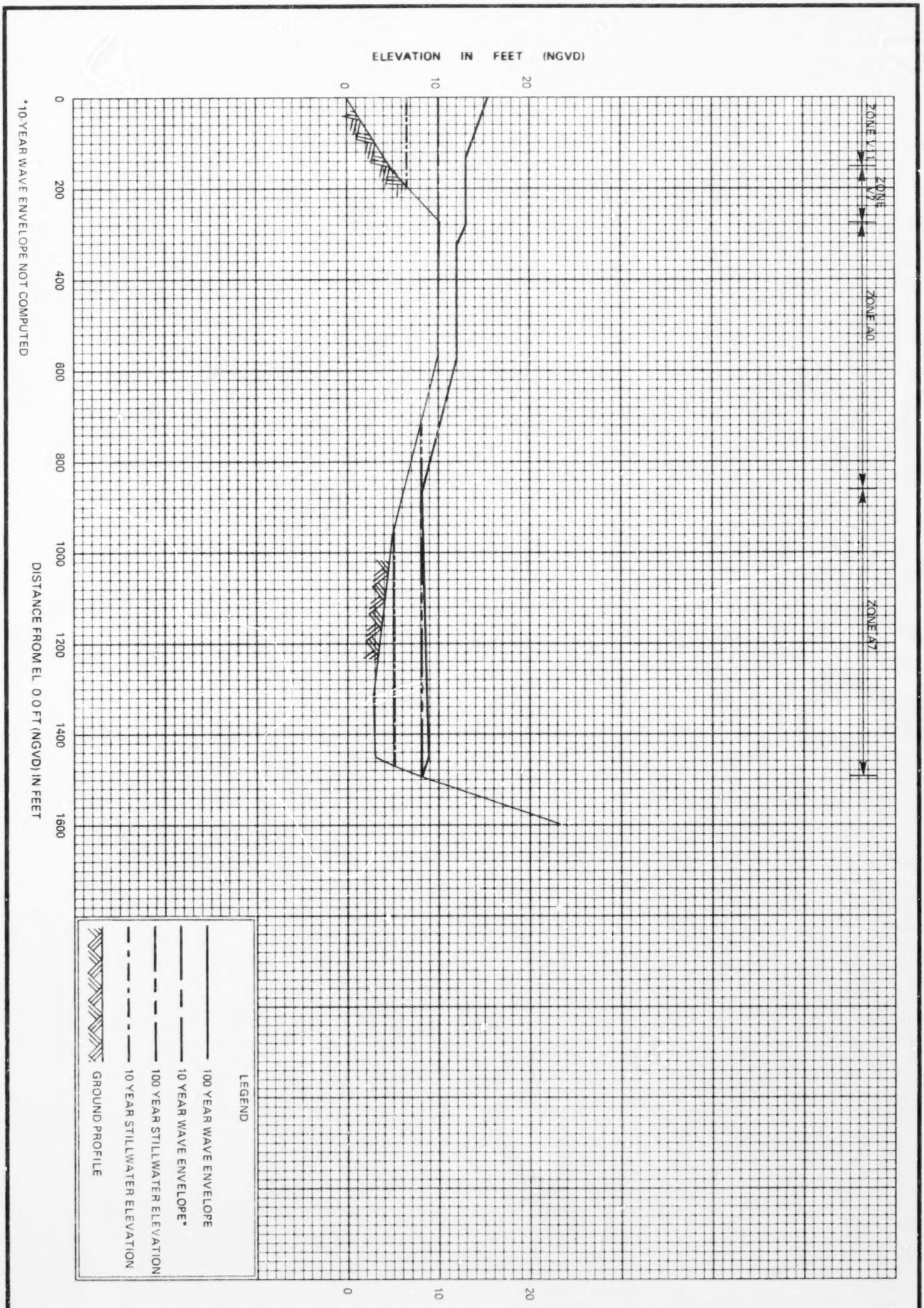

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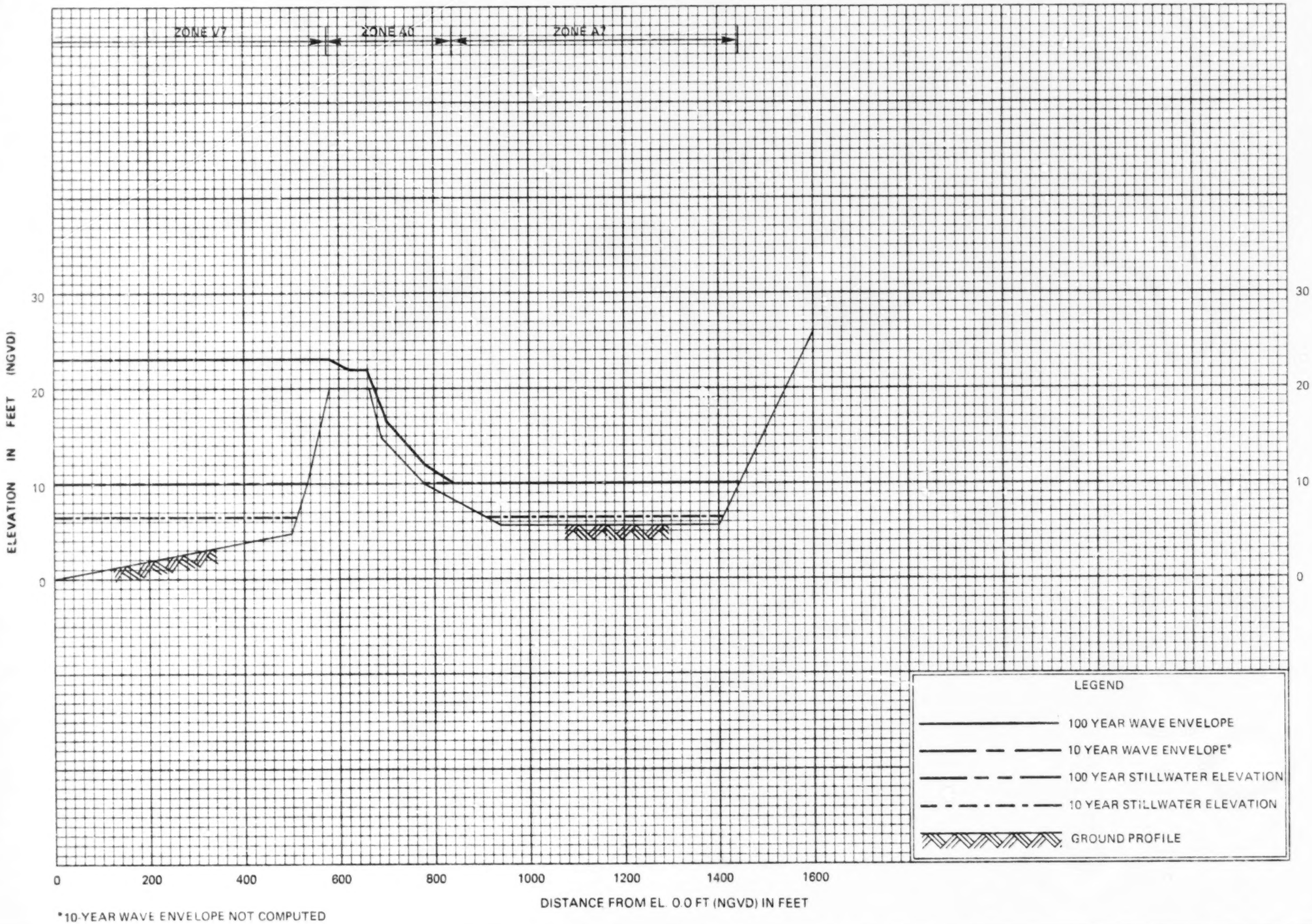

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TOWN OF ORLEANS, MA
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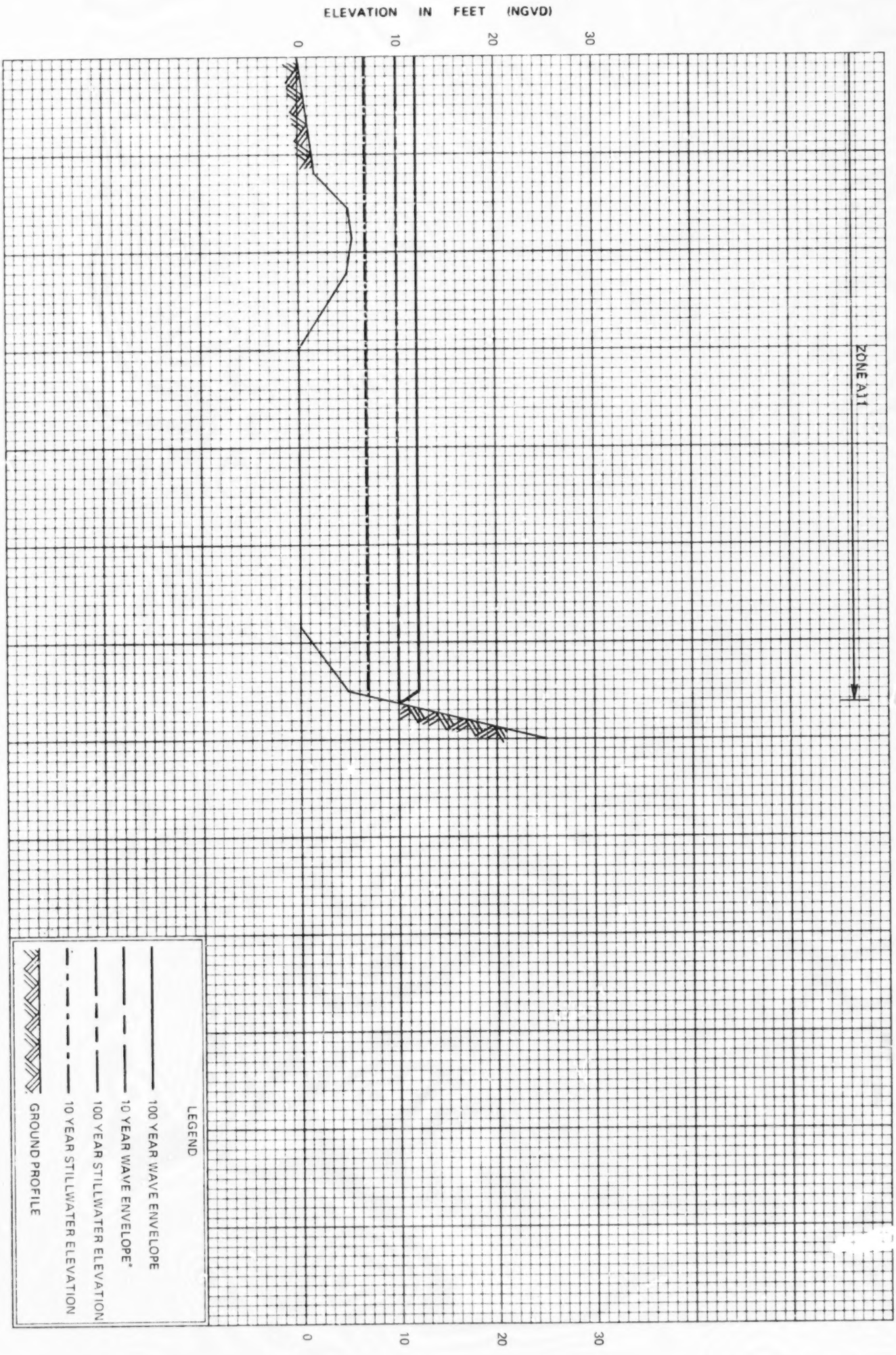

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TOWN OF ORLEANS, MA
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COASTAL PROFILES

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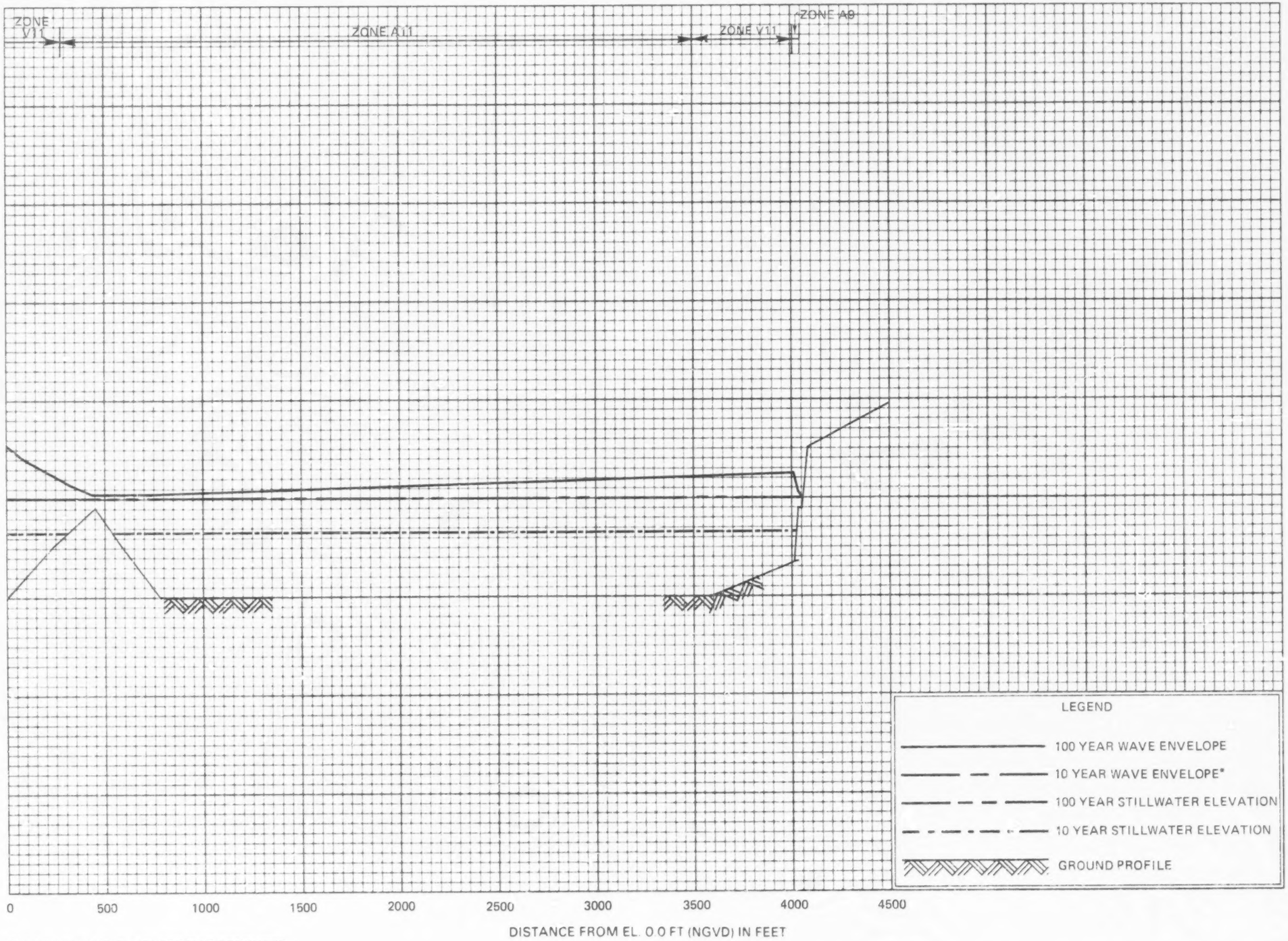

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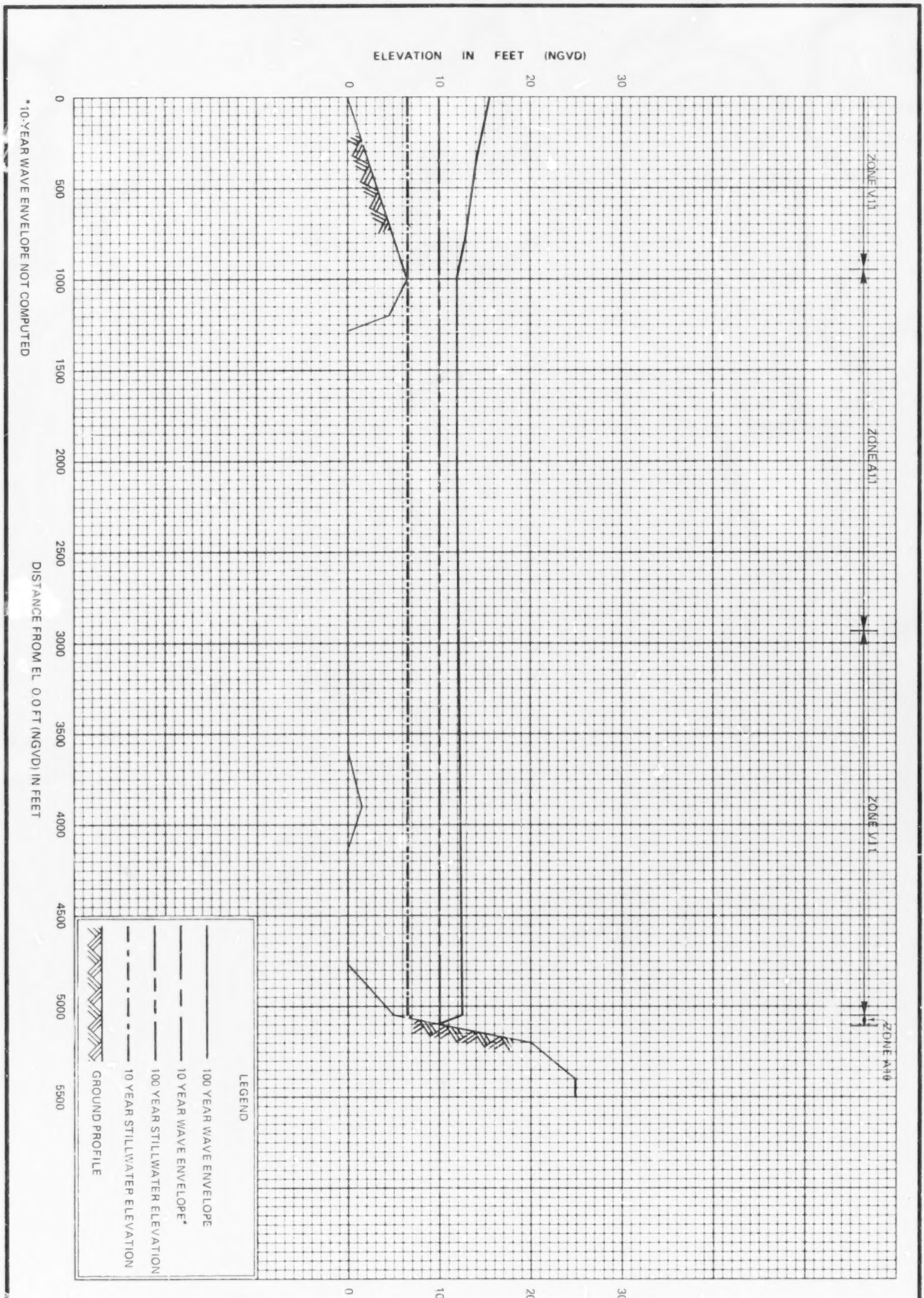

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TOWN OF ORLEANS, MA
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COASTAL PROFILES

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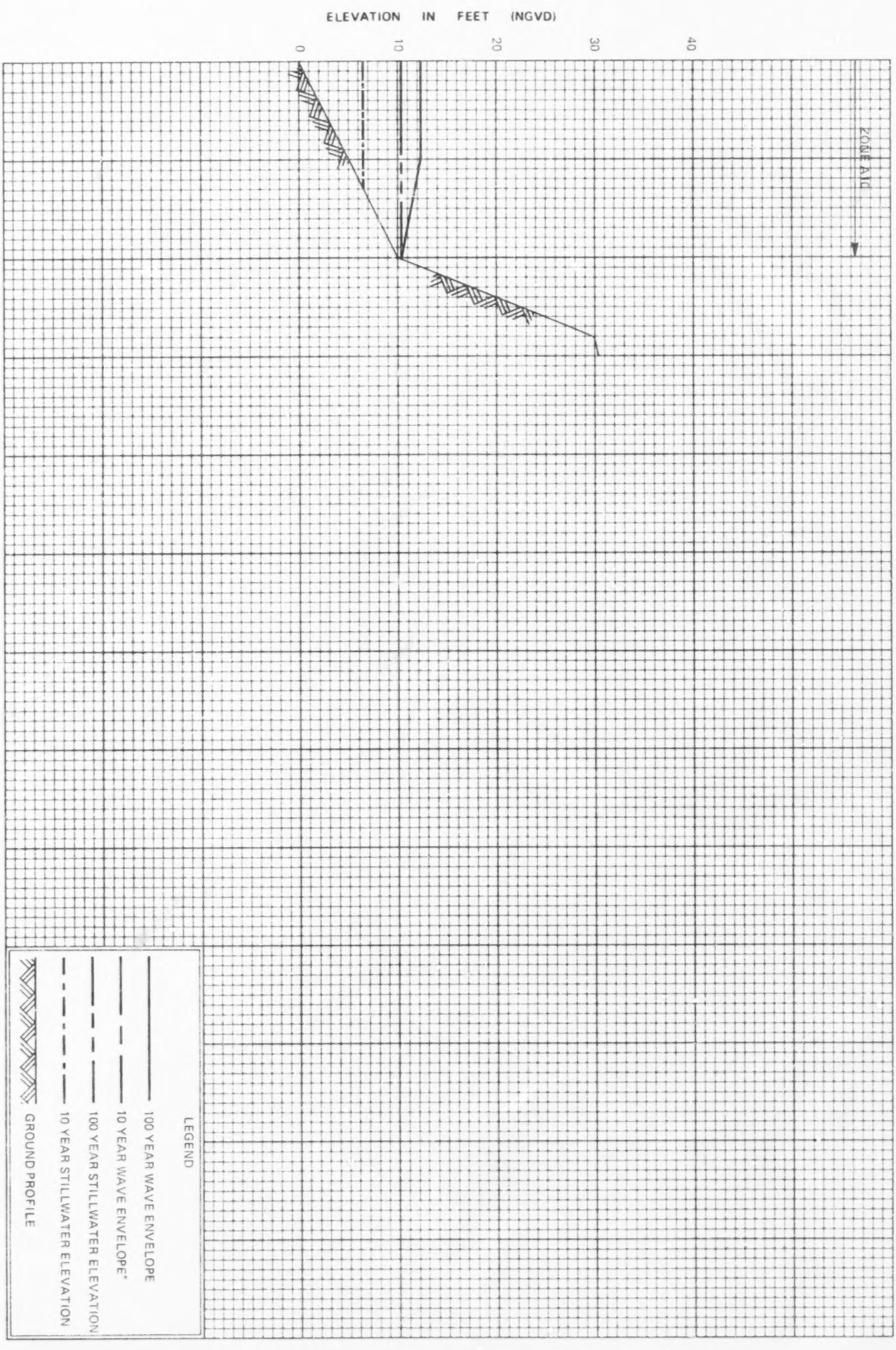

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TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

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COASTAL PROFILES

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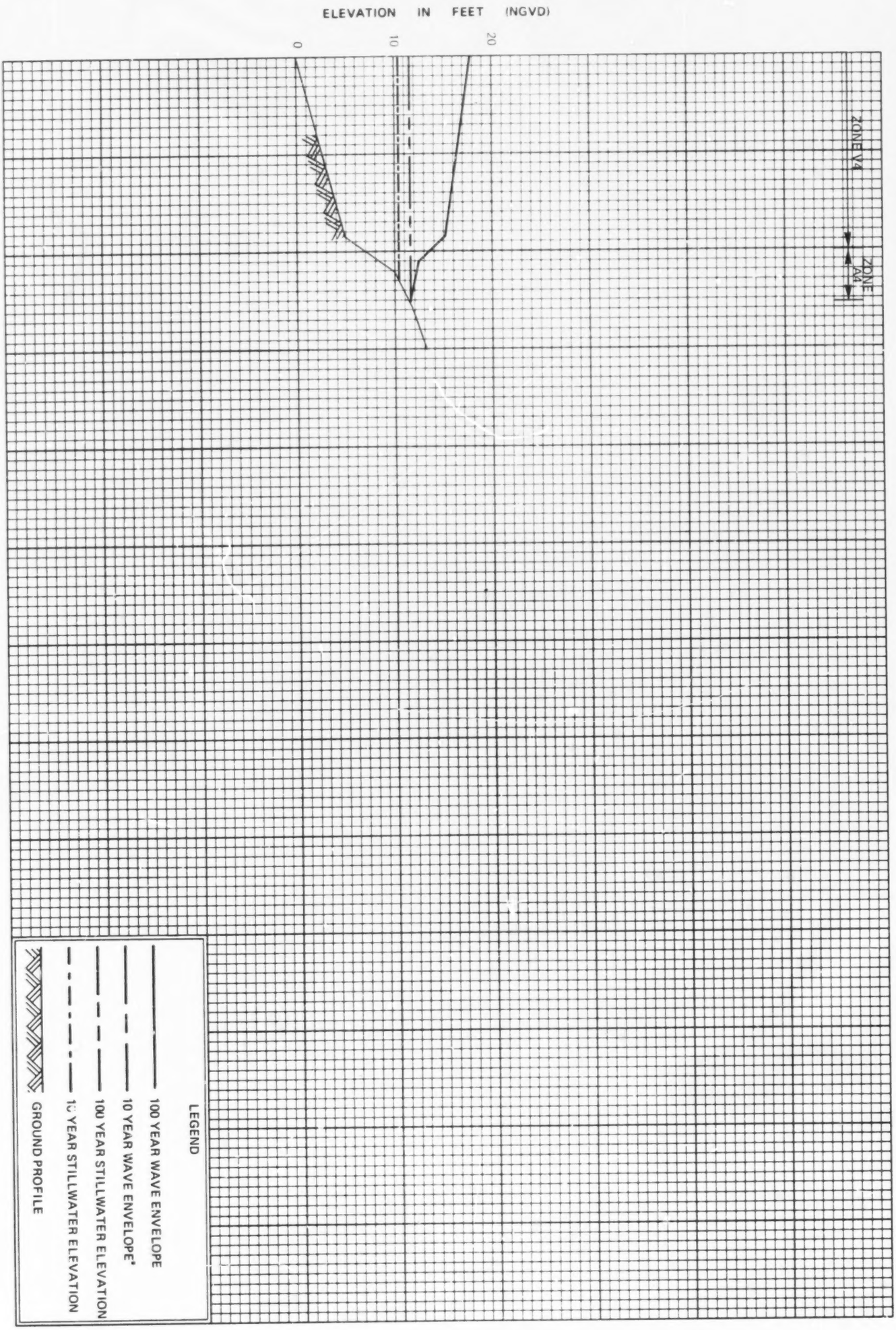

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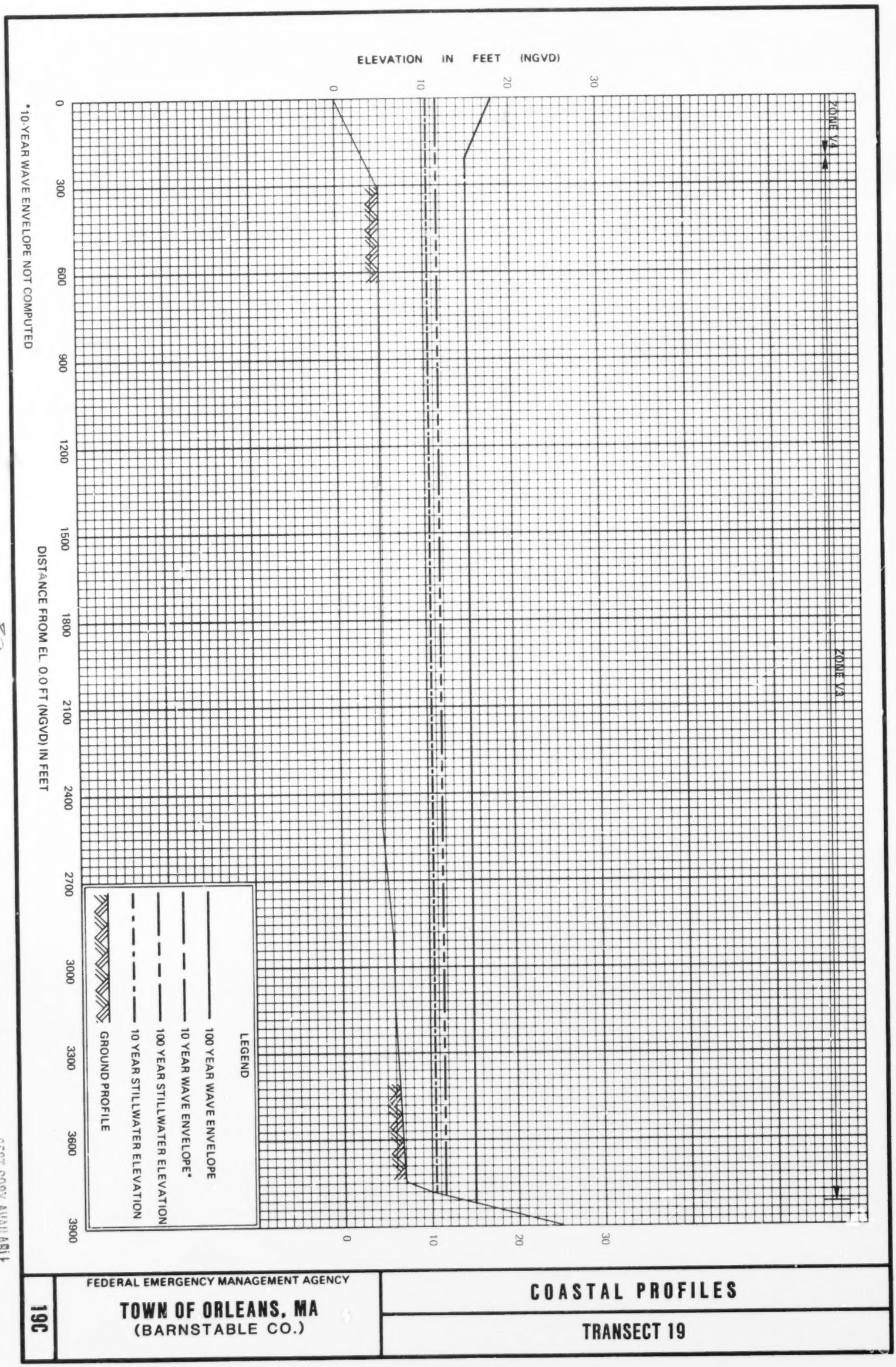

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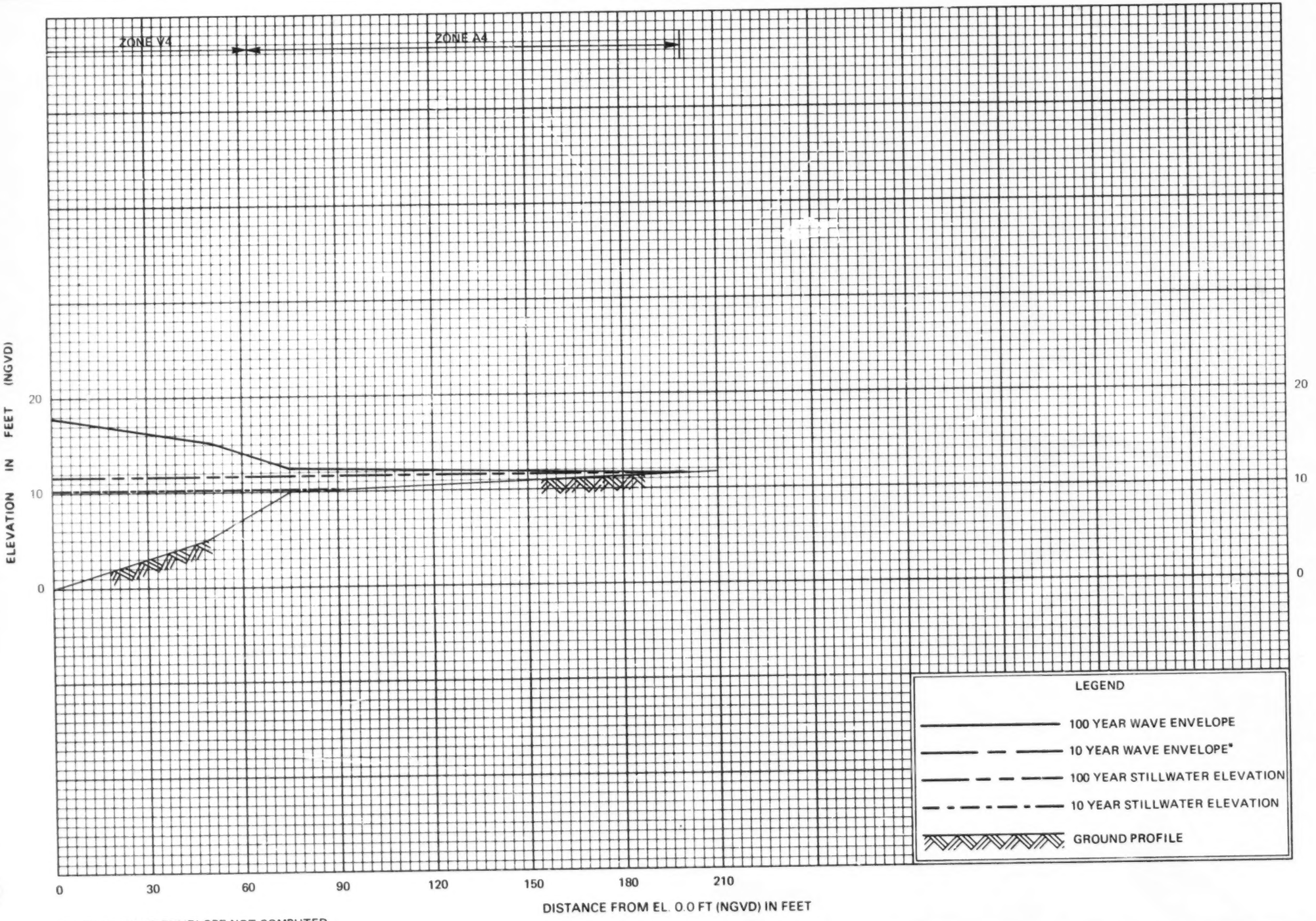

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COASTAL PROFILES

TRANSECT 20

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TOWN OF ORLEANS, MA
(BARNSTABLE CO.)

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